

**TRAFFIC SIGNAL COORDINATION  
PLANNING EFFORT**

**Traffic Engineering Division  
Colorado Springs, Colorado**

**April 2005**

# PURPOSE OF THE REPORT

This report sets forth a flexible plan that will guide us in our efforts to improve traffic signal coordination along our heaviest traveled arterial streets. Over the years, traffic flow along these streets has grown rapidly due to community growth and dependence on the automobile. To address this growth, we need to continually examine our plans, practices and policies to improve our performance.

With this plan, we are focusing on efforts to improve traffic signal coordination. Such signal coordination ranks as one of the most cost effective and successful strategies to reduce congestion problems. Each dollar spent optimizing signal timing and implementing system improvements can yield up to \$40 in fuel savings.

Additionally, signal coordination can also have a dramatic impact on the drivers themselves. As most of us realize, delays and frustrations caused by the operation of traffic signals can lead to accidents and road rage.

By bettering our equipment, maintenance practices, and signal programming methods, we can improve the lives of our motoring public by shortening their travel times and providing easier drives.

This report provides a brief discussion on the benefits of coordinating traffic signals, signal timing efforts, influencing factors, complementary system operations, and short-range improvements.

## Benefits of Signal Coordination

We coordinate traffic signals to insure optimum travel speeds, reduced delays, and minimal stops. As national studies indicate, coordinating previously uncoordinated signals can result in a reduction in travel time ranging from 10% to 20%.

According to our own recent studies conducted along Academy in February, there is a 10% to 30% improvement in travel times resulting from coordinated signals. These studies coincided with the traffic signal upgrade project, which shut down signal coordination along the Academy corridor for equipment upgrades.

Other benefits of signal coordination include the following:

- Improved mobility and access
- Bolstered local economies
- Reduced vehicular accidents
- Reduced energy and fuel consumption
- Eliminated or delayed street widening needs
- Improved emergency response
- Reduced motorist frustration and road rage
- Reduced vehicle wear
- Increased control of travel speeds
- Reduced diversionary flows in neighborhoods
- Reduced vehicle emissions
- Real-time traffic monitoring
- Advanced equipment monitoring



## Today's Signal Coordination Efforts

We have operated coordinated traffic signal systems for the past forty years—since signals began populating our streets. As the years have progressed, our skills and systems have done so also. Through years of experience, we have produced optimal signal timings that address the unique and dynamic conditions existing on each of our busy corridors.

Our progress is now aided by computer software that models the flows and corridor conditions to provide the best practical timing solutions. In addition, our signal systems will have state-of-the-art electronic upgrades to rapidly change and operate signals to meet traffic demands.

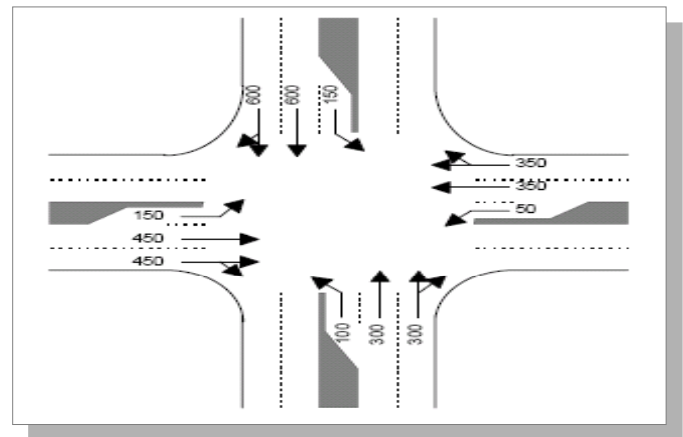
To ensure that we are doing our jobs well, we have developed a **Traffic Signal Timing and Coordination Program** intended to reevaluate our practices and procedures. This program anticipates continued development of new coordination and timing plans on a reoccurring basis. Using three to five year cycles for major corridors, we will monitor and address growth, operations, and traffic pattern changes.

As part of this program, we have also formed a **Traffic Signal Timing Team** consisting of City's traffic engineers and technicians who specialize in the timing and coordination of the City's traffic signals. Our team's objective is to study and re-evaluate approximately 30 to 40 arterial streets a year to optimize coordination. This involves producing timing plan strategies that improve the peak and non-peak periods.

In this process, our team members gather data including turning movement counts, hourly flows and speed surveys. They perform comprehensive signal timing optimization services including the application of computerized models to design, evaluate and optimize signal timing plans. This includes the evaluation of more than 500 signals, including grid and arterial networks, irregular signal groups, inter-jurisdictional signals, complex intersections, and operational interfaces with freeway interchanges.

Lastly, to ensure that we produce the best plans, we drive the arterial before and after the new coordination timing is applied to determine the effectiveness and efficiency of the new coordination. Once the optimal coordination has been determined, we implement the new timing.

This program is consistent with the best practice approach used by many cities to improve their signal system. We believe it has produced coordination results that provide the highest level of service for our motoring public.



# Complications that Impact Signal Coordination Plans

Traffic signal coordination plans are strongly influenced by dynamic conditions such as corridor speeds, traffic signal spacing, congestion, traffic volumes on major streets, pedestrian volumes, traffic signal cycle lengths, additional phasing, and safety considerations. Each factor can significantly complicate good coordination schemes. Below are descriptions of these influencing factors, and the resulting conditions that may be undesirable for our driving public.

## CORRIDOR SPEEDS

Signal coordination plans are established by using prevailing travel speeds. Motorists traveling at these speeds will achieve optimal travel times; however, those traveling above or below the prevailing speed may have significantly greater stops and delays as they are traveling outside the progression band.

## TRAFFIC SIGNAL SPACING

Well-coordinated timings are established when signals are uniformly spaced along busy streets. For most busy corridors, spacing would be approximately 1/2 mile. However, while newly developed arterial corridors provide signal spacing in accordance with access management policies, the older developed corridors do not have proper signal spacing which can result in more stops and delays.

Traffic signal coordination plans are limited when it comes to signal spacing. Signals are typically spaced no more than 3/4 miles apart, as distance can cause the break up of platoons due to access

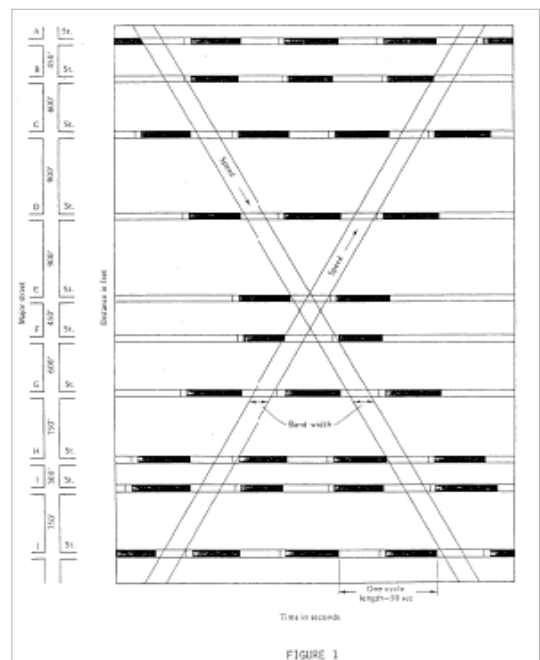
movements, lane changes, truck traffic, varying travel speeds, geometric conditions and other elements. Without regulation, motorists may have more stops and delays than expected.

## CONGESTION

Our plans are detrimentally impacted when capacities at our busiest intersections are exceeded. Under such conditions, traffic signal operations can not fully serve the demand, resulting in limited progression. In such cases, strategies may include serving only the heaviest directional flows.

## TRAFFIC FLOW CHARACTERISTICS

Our signal coordination plans are strongly influenced by the volume of total traffic, the directionality of the traffic, and the amount of traffic entering, exiting or crossing from a side street. In most cases, our traffic signal coordination is designed to favor the heavier traffic flow. This may cause frustrations for motorists driving in less traveled directions as they may experience more stops and delays than desired.



## PEDESTRIAN VOLUMES

We are very sensitive to the needs of pedestrians and bicyclists. To serve them safely, we have pedestrian signal phases at nearly all crossing locations. Though good for pedestrians, these phases reduce our proportional green time for thru-traffic on major streets. Reducing green “thru” bands affect coordination since it narrows the window when motorists can travel through the intersection without stopping.

## TRAFFIC SIGNAL CYCLE LENGTHS

Traffic signals must operate under the same cycle length along a coordinated network to produce consistent results. These cycle lengths are typically set to serve the needs of the busiest intersection as well as provide the optimal coordination along the corridor.

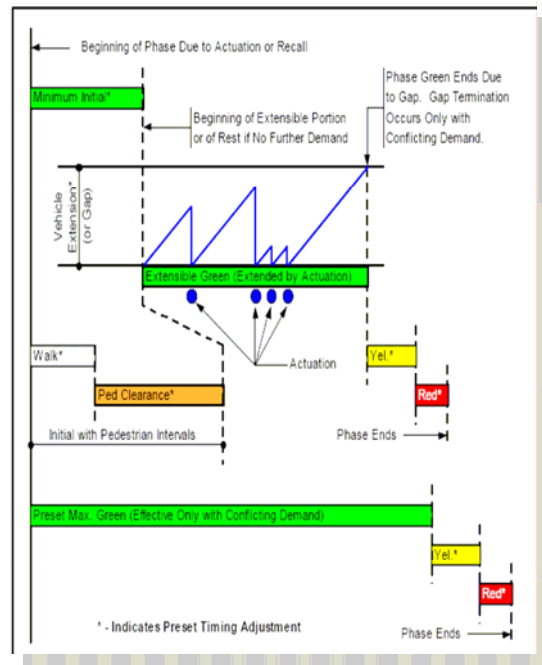
As volumes grow on our major streets, cycle lengths increase. This is due primarily to the extended green phase times needed to serve the approach traffic demands. This may cause some delay at minor signalized approaches. In some situations, motorists traveling on side streets may experience longer delays than expected.

## ADDITIONAL LEFT TURN SIGNAL PHASES

We are careful when adding left-turn phases along our busiest corridors due to their effect on green phase bands. Because our cycle lengths are fixed, each additional left-turn phase can reduce “thru” green times by as much as 25% to 40%. As a result, the reduced green “thru” bands can narrow the window allowing motorists to travel through the intersection without stopping.

## SAFETY CONSIDERATIONS

We must address safety first when developing traffic signal timing plans. Each switch of the lights from green to red includes a five (5) second yellow phase and a two (2) second “all-red” phase. The yellow phase allows drivers to pass through the intersection when they are beyond the stop bar. The all-red phase provides additional time for motorists who are in the “dilemma zone” where decisions between stopping and proceeding through the signal are difficult to make. However, this phasing can adversely impact the green phase times on major and minor streets, widening progression bands.



# Systems Working Behind the Scenes to Coordinate Traffic Signals

The success of our signal coordination efforts rely on system features that provide communication, fault-reporting programs, reliable detection, real-time surveillance, traffic reporting capabilities, and responsive timing program implementation. Without these functions, our signal timings would not provide the desired effect. Described below are the key systems that work to provide signal coordination.

## Communication Links to Signals

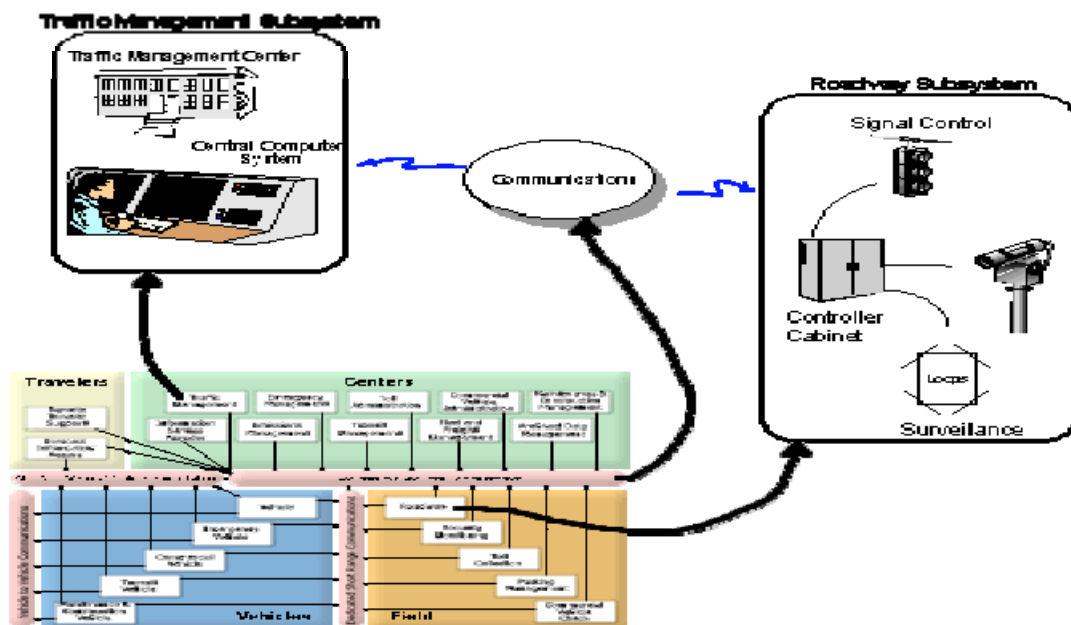
Communication links between traffic signals allow them to work together. This signal coordination allows greater opportunity for motorists to travel through adjacent traffic signals without making unnecessary stops. Future communication links will include radio and fiber connections to nearly all signalized intersections so they can receive commands and data from our centralized master “controller” equipment.

## Traffic Signal Controller Equipment

Our traffic signals operate with their own “brain,” also known as an electronic “local” controller device. This controller is specifically programmed with appropriate time and plan settings to meet approach traffic demands. Time-of-day plans are changed throughout the day by instructions received from the master “controller” equipment. This equipment also provides the necessary synching technologies to maintain coordination.

## Advanced Traffic Detection Systems

The “eyes” of the City’s signal system are the vehicle detectors that provide messages to the signal controllers. The signal controllers then alter their operations to skip or extend phases depending on vehicle demand registered by the detectors. These detectors include the new video equipment that improves detection efficiencies at signalized intersections.



## Strategic Plan to Improve Signal Coordination and Reporting

With this strategic plan, we are making a concerted effort to enhance our traffic signal system. To implement this plan, we will focus our attention to four key areas. These areas include:

- **Signal Coordination Plans**
- **Signal Equipment**
- **Traffic Benchmarking and Reporting**
- **Public Information and Outreach**

Ultimately, our goal in this effort is to hold peak travel times to less than 1% increase on City streets. This is an ambitious performance goal, considering that traffic growth is more than 3%, and many intersection capacities are exceeded along these routes.

Described in the following section are key service improvements, schedules, and funding needed to complete the plan.



# Plan Element #1

## Coordination Plan Enhancements

The most highly prioritized effort in our strategic plan is to reevaluate our traffic signal coordination plans on an ongoing basis. This is important due to the changing characteristics of traffic flow caused by traffic growth, area development, and traffic diversions as a result of construction. It is also important because of new techniques and practices that can be used to evaluate coordinated signal timings. In this effort, we will improve our performance in all key coordination areas by:

- Evaluating strategies and implementing plans to improve traffic signal coordination for off-peak and peak periods by taking advantage of computer generated signal timing programs, upgraded equipment, new technology, and/or enhanced signal timing philosophies. This includes researching timing and progression schemes used along fully congested corridors by other communities.
- Inviting outside “experts” to the community who will evaluate signal timings along our busiest corridors where capacities are exceeded.
- Developing a master plan for diversion traffic flows resulting from construction of Rural Transportation Authority (RTA) and I-25 projects.
- Using “travel-time” benchmarking tools to focus on specific corridors where travel times are increasing.

Our schedule calls for implementing new coordination improvement plans that will coincide with the traffic signal controller upgrades along the major corridors. As part of the upgrade, software and hardware containing new timing plans will also be implemented. Schedules call for implementing the new upgrades and programs by 2005.

Our goals to evaluate strategies and implement new plans rely on the Congestion Mitigation and Air Quality Project (CMAQ) funding in 2006 and 2007. With this funding, staff can perform detailed studies of the corridor to adjust signal phases, offsets, and cycle lengths to improve coordination. Focus will be on the most deficient intersections that operate under congestion conditions. CMAQ funding applications are currently being drafted for review, and the approval process will be conducted later this year.

As described in this section, the benchmarking of travel times along our busiest corridors will begin later this year after new coordination plans are implemented. This benchmarking program will be funded through the RTA.

## Plan Element #2

### Signal System Enhancements

Another highly prioritized effort to improve signal timings relies on future technological enhancements to system components. Projects that must be completed in 2005 to set the stage for improved traffic signal timing and coordination plans are listed below.

- **Installation of a new radio data communication system.** This system will operate and synchronize traffic signals, as well as provide communication capabilities for the Automated Vehicle Locator (AVL) system. In addition, it will provide a more reliable and responsive communication system when completed.
- **Upgrade of “local” traffic signal controllers.** As part of this year’s project work, the software and hardware components of the signal’s controllers will be upgraded. With these upgraded programs, the City’s traffic signal system will have the capability to receive and send data communications needed for surveillance, coordination, AVL, and other traffic services.
- **Expansion of the “video” detector system.** A project is planned for expanding the use of the video detection units to improve the traffic signal systems. This includes the installation of units along “fixed-time” signalized corridors now operating without detection. With these detectors, the intersections can revert to an “actuation” type of operation during various periods to be more responsive to flow demands. These corridors include those along

the Downtown Business District and the Cache La Poudre corridor.

Radio installation and controller upgrade work commenced this past year with funding from the CMAQ program. Schedules call for completing this work by the end of 2005. Work to install additional “video” detectors will be phased in with other RTA work this spring. Costs will be approximately \$200,000 for the labor and materials needed to install the video detectors.



# Plan Element #3

## Benchmarking & Reporting Corridor Conditions

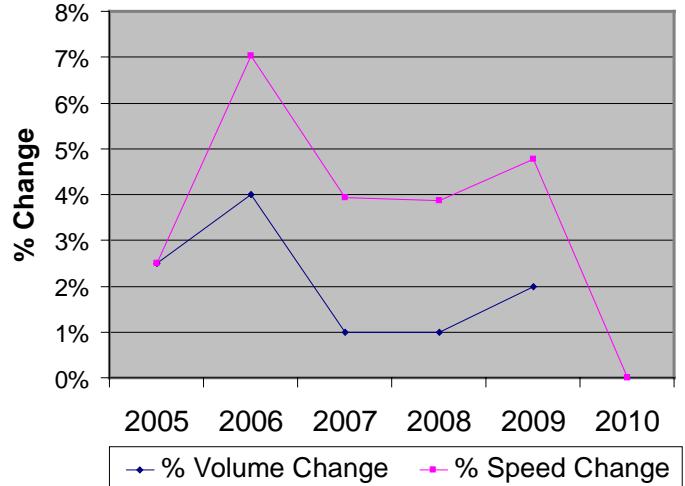
As part of our strategic plan, we feel it is important to monitor our busiest corridors over time to assess our performance. This will be done by measuring travel times along these corridors and assessing them based on corridor speed and collective delays experienced along the route. By conducting this survey, we would be able to provide reference information each year that could be compared to the traffic growth rate along these corridors.

While congestion indexing reports will be provided to the public, other information collected in this process will be used internally to identify those corridors warranting signal timing adjustments, coordination and/or other improvements.

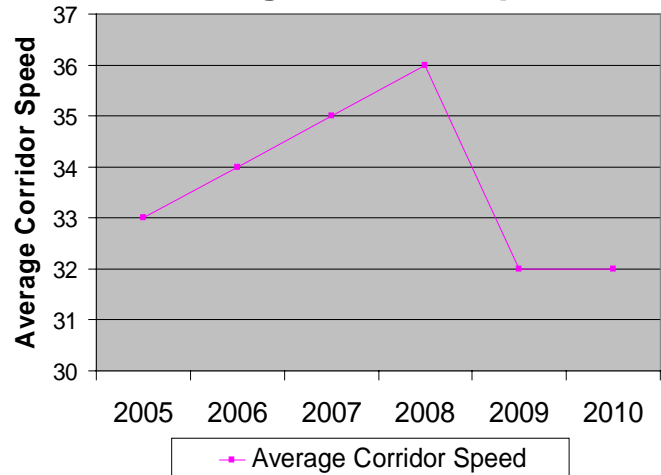
The first step in this plan has been completed by identifying the corridors that would be evaluated over time. These corridors include the major travel corridors within the City with the highest traffic volumes, congestion, and number of signals.

Schedules call for completing this benchmarking and reporting work by the end of 2005, once system improvements are implemented. The cost of this project will be approximately \$25,000, which could be supported by the general fund.

### % Speed and Volume Changes



### Average Corridor Speed



## Plan Element #4

### Public Communication Element

Our public communication work is an important element to the success of this coordination effort. We need to inform the public about what we are doing to address their concerns and requests. We must also inform them about the less obvious conditions we deal with that produce coordination plans. To address some of these conditions, we may need to make the public aware of alternatives and seek their input to determine solutions.

